On the ultimate Composition of simple alimentary Substances; with some preliminary Remarks on the Analysis of organized Bodies in general. *By* William Prout, *M.D. F.R.S.* Read June 14, 1827. [*Phil. Trans.* 1827, *p.* 355.]

The author commences by observing, that the present is the first of a series of communications, which he hopes to have the honour of laying before the Royal Society, on the same subject; and that the object of the whole series is to determine the exact composition of the three great divisions, viz. the saccharine, the oily, and the albuminous, in which the alimentary matters employed by the more perfect animals may be comprehended; and afterwards to inquire into the changes induced in them by the action of the stomach and other organs, during the subsequent stages of assimilation.

The present paper includes some preliminary observations on the analysis of organized bodies in general, and the composition of the first of the above classes, viz. the saccharine.

After an historical sketch of the principles and progress of the analysis of organized substances, the author makes some remarks on the difficulties attending the use of oxide of copper as now employed. He observes that it is not only hygrometric, but, like many other powders, also condenses air. He likewise found, that when the oxide was removed from the tube in which the combustion had been effected, and retriturated, and reburnt (as in most instances was necessary), it almost invariably gained, instead of losing, weight; a circumstance which he ascribes to the combination of the oxygen of the air contained in the tube, with the partially reduced oxide of copper. These sources of error, from their variable and uncertain character, he found it impossible to ascertain, and was at length obliged to adopt another principle.

When a substance composed of hydrogen, carbon, and oxygen, is burnt in a given quantity of oxygen gas, one of three things must happen; either the volume of the gas will not be changed, in which case the hydrogen and oxygen must exist in the substance, in the proportion in which they form water; or, secondly, the volume may be increased, in which case the oxygen must exceed that proportion; or, lastly, it may be diminished, when the hydrogen must predominate. These well-known facts the author has taken advantage of for determining the composition of vegetable substances, and proceeds to describe the apparatus he employed for that purpose, which consists essentially of accurately graduated syphon gasometers, placed at a convenient distance from one another, so that they may be readily connected by means of an intermediate tube, in which the substance to be analysed is introduced. Heat is applied to this tube by means of a spirit-lamp, and the oxygen gas transferred, by means of mercury, from one gasometer to another, through the ignited tube. After the operation, the difference of volume, as compared with that of the oxygen originally employed, shows the composition of the substances. The author then details some precautions necessary to be observed in

the process, and points out some of its peculiar advantages; the chief of which is, that it is not liable to be affected by moisture.

The composition of the saccharine principle is next considered, under which term he includes all those substances in which hydrogen and oxygen unite, in the proportion in which they form water. These are all alimentary, or capable of becoming so; and, as they are chiefly derived from the vegetable kingdom, the author considers them as peculiarly deserving the name of vegetable aliments. Sugar is first examined; of which he states that there are at least two distinct varieties, and probably many more (besides the sugar of milk). The most perfect form of this principle is sugar-candy prepared from cane-sugar, the composition of which he states to be, carbon 41·379, and water, 58·261; identical in composition with which are all the most pure specimens of the loaf-sugar of commerce. Sugar, in this state, contains water of crystallization; and the author states that he shall give his reasons at length for considering this principle, in the abstract, as consisting of carbon 44·44, and water 55·55.

The other variety of sugar, considered by the author as distinct, was obtained from Narbonne honey. This was beautifully white, and crystallized in spherules; deprived of its hygrometric water, it was found to consist of carbon 36·36, and water 63·63. Between these two extremes, sugars of almost every possible grade occur; probably, in many instances, from mixture of the above two varieties. Some analyses of other sugars are given, such as East India sugar-candy and refined sugar; the sugar from the maple, beet-root, &c.

The next class of bodies considered, is the amylaceous, and the author commences with some remarks on the sense in which he employs the term Protorganized. He states that he has satisfied himself, from many observations, that the minute quantities of foreign bodies found in all organic products, instead of being mechanically mixed with them, as usually supposed, perform the most important functions; in short, that organization would not exist without them; that when a crystallized substance passes into the organized state, its chemical composition frequently remains essentially the same, and that the only difference that can be traced in it is the presence of a little more or less of water, and invariably of minute portions of some of the foreign bodies above alluded to; and that these appear not only to destroy its power of crystallizing, but usually to change entirely its sensible properties. This subject he promises fully to illustrate hereafter, but proposes in the mean time to adopt the word Protorganized, to designate all those substances formed essentially on the principles of crystallized bodies, but not capable of assuming that form, probably on account of the presence of the foreign bodies above alluded to.

Starch from wheat, the author considers as the most perfect form of this principle; the carbon from which varies from 38 to 40 per cent., according to the degree to which it has been dried. Arrow-root, which may be considered as a *low* variety of starch, analogous to the low sugar of honey, contains still more water, capable of sepa-

ration, than wheat-starch. It is to the want of attention to these circumstances that the author assigns the different results given by chemists with respect to the composition of this principle; which in the abstract, or free from water, he considers as identical with cane-sugar similarly circumstanced.

The next principle considered is vinegar, a substance that in almost all ages and countries, either by accident or design, has been more or less used as an aliment. The author states that he had reason to suspect long ago that the hydrogen and oxygen in this acid existed in the proportions which form water, but that he was not completely able to satisfy himself on the point till he employed the present apparatus. He decided the point by means of the acetate of copper, which produced no change of bulk in the oxygen employed. He states this acid to consist of carbon 47·05, and water 52·95; results that very nearly agree with those of other chemists. This principle is not, however, in the protorganized state, except the acid found in almost all animal matters, and hitherto called the Lactic acid, be deserving of that appellation.

The last substance connected with this series is *lignin*, or the woody fibre, a principle subject to all the varieties of starch before mentioned. The author finds the composition of this principle, in the abstract, as containing carbon 57·14, water 52·86; and observes, that he is not acquainted with it in the crystallized state, but that he has no doubt of its existence. In proof of the alimentary qualities of this principle, he quotes the experiments of Professor Autenrieth, of Tubingen, who states that when wood is reduced to a minute state of division, and subjected to other processes, which he describes, it is capable of gelatinizing like starch when boiled in water, and of forming bread.

The sugar of milk is next considered. This, in its crystallized state, is composed of carbon 45·45, water 54·54. Gum-arabic, according to the author, is this substance in the protorganized state, and, like all analogous substances, combines with any proportion of water; and hence the different compositions assigned to it by different chemists.

As connected with this subject, the author next proceeds to consider the oxalic, citric, tartaric, and saccholactic acids, the composition of each of which is given; and concludes by observing, that he purposely refrains from all chemical observations, till the whole of the facts in his possession are laid before the Society.

Experiments to ascertain the Ratio of the Magnetic Forces acting on a Needle suspended horizontally, in Paris and in London. By Captain Edward Sabine, *of the Royal Artillery, Sec. R.S.* Read June 21, 1827. [*Phil. Trans.* 1828, *p.* 1.]

The needles used in these experiments were cylinders 0·16th of an inch in diameter, and 2·4 inches in length, pointed at the ends, and suspended by a silk fibre 5 inches long, over the centre of a graduated